PROCEEDINGS OF SCIENTIFIC SOCIETIES.

NINETEENTH MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, HELD AT TROY, N. Y., AUGUST 17TH–24TH, 1870. The nineteenth meeting of the Association opened with about one hundred and fifty members. During the meeting about fifty more members entered their names, and one hundred and seventy-one new members were elected. The total number of papers entered amounted to 144, of which 30 were read by title only and 7 were excluded.

The Local Committee had secured convenient rooms for the general sessions, and those of the several sections, at the Court House, the Troy Female Seminary and the First Presbyterian Church. The local secretaries, Messrs. B. H. Hall and H. B. Nason, who, as usual, had the greater part of the Local Committee work on their hands, did all in their power to make the meeting a success, and to furnish accommodations and aid to the members in attendance.

A large and brilliant reception was given to the Association by His Honor Mayor GILBERT, on Thursday evening, and an equally brilliant one by Hon. JOHN M. FRANCIS at his residence, on Monday evening. Monday was occupied by an excursion to Saratoga and dinner at Congress Hall, at the invitation of the citizens of Troy. On Friday morning the Association steamed down the river to Albany, where they were the guests of the ALBANY INSTITUTE and were most hospitably entertained, and visited the *Dudley Observatory*, *State Cabinet*, and the large *private collection* of Professor HALL. Gathering at the *State Library* at half past four o'clock a most delightful evening was passed at a levee given by the Albany Institute, after which a fine sail up the river brought all back to Troy before midnight. "Section Q" was well carried out on Tuesday night.

During the evenings of the session many members availed themselves of the opportunities afforded for visiting the *Bessemer Steel Works*, the *Burden Iron Works*, and the *Rensselaer Iron Works;* the proprietors and superintendents of all the works being most obliging and courteous to the throngs of visitors who invaded their firey quarters.

The address of the Retiring President, J. W. FOSTER, was delivered on Thursday evening, at the First Presbyterian Church. This address is of such general interest that we print it in full in this number.

The following were the officers of the Troy meeting:—T. STERRY HUNT,* of Montreal, *President;* JOSEPH LOVERING, of Cambridge, *Permanent Secretary;* F. W. PUTNAM,† of Salem, *General Secretary;* A. L. EL-

*In the absence of President CHAUVENET, detained by illness, Vice-President HUNT became the presiding officer of the meeting.

†Professor HARTT being absent on his expedition in Brazil, Mr. PUTNAM was elected as General Secretary.

WYN, of Philadelphia, *Treasurer*. *Standing Committee*—T. STERRY HUNT, JOSEPH LOVERING, F. W. PUTNAM, ASA GRAY, F. A. P. BARNARD, J. W. FOSTER, O. N. ROOD, JOHN TORREY, E. D. COPE, E. N. HORSFORD, J. E. HILGARD, A. WINCHELL, H. B. NASON. *Section A.—Mathematics Physics, and Chemistry*—F. A. P. BARNARD, of New York, *Permanent Chairman;* G. W. HOUGH, of Albany, *Secretary;* G. W. MAYNARD, of Troy, ELIAS LOOMIS, of New Haven, S. D. TILLMAN, of New York, *Sectional Committee*. *Subsection C of Section A.—Microscopy*—S. S. HALDEMAN, of Philadelphia, *Permanent Chairman;* R. H. WARD, of Troy, *Secretary*. *Section B.—Geology and Natural History*—ASA GRAY, of Cambridge, *Permanent Chairman*, and afterwards A. H. WORTHEN, of Springfield, Ill., and JAMES HALL, of Albany; HENRY HARTSHORNE, of Philadelphia, *Secretary*, and afterwards THEODORE GILL, of Washington; JAMES HALL, of Albany, J. G. MORRIS, of Baltimore, ALPHEUS HYATT, of Salem, *Sectional Committee*. *Subsection E of Section B.*—for one day, Tuesday, Section B. was subdivided, and THOMAS HILL, of Waltham, was elected *Chairman*, and W. H. DALL, of Washington, *Secretary*.

At the last session of the meeting it was voted to accept the invitation of the CALIFORNIA ACADEMY OF SCIENCE to hold a future meeting of the Association at San Francisco, and a committee was appointed to make arrangements for holding the meeting of 1872 in that city.

It was also voted to accept the invitation from Indianapolis, presented by the State Geologist of Indiana, E. T. COX, to hold the twentieth meeting at Indianapolis, commencing on the *Third Wednesday of August*, 1871.

The following officers were elected for the next meeting:—*President*, ASA GRAY, of Cambridge; *Vice-President*, GEORGE F. BARKER, of New Haven; *Permanent Secretary*, JOSEPH LOVERING, of Cambridge; *General Secretary*, F. W. PUTNAM, of Salem; *Treasurer*, WM. S. VAUX, of Philadelphia.

We give abstracts of several of the papers read in Section B. in this number of the NATURALIST, as well as the President's Address. In the November number we shall print others received from the authors, and shall also give extended abstracts of the several papers read in the Subsection of Microscopy, including two on the Binocular Microscope; one by President Barnard of Columbia College, and the other by Dr. Ward of Troy. We shall also then give a list of the papers read in Section B. of which we have not received abstracts, but we trust that it will be a short one, and at this time request those authors who have not yet sent us the promised abstracts to do so at once.

Prof. EDWARD S. MORSE read a paper "On the early stages of Discina." Referring to his communication last year on the early stages of Terebratulina, and the evidence then adduced of the proofs of the close relations existing between the Brachiopoda and the Polyzoa; he said that an examination of the early stages of Discina showed the same simple lophophore, sustaining a few cirri, the stomach hanging below, and other features in which a resemblance was seen.

The perivisceral wall is made up of two layers of muscular fibres which cross each other, giving it a reticulated appearance. While the young shell is oval in shape there is marked out a perfectly circular area, indicating that at the outset the embryo possesses a circular plate above and below. The muscles were very large and occupied most of the perivisceral cavity. The setæ fringing the mantle were very long, those from the anterior margin being nearly three times the length of the shell. The mantle margin, the blood lacunæ, and the bands of muscles to move the setæ were all described.

He also spoke "On the organization of Lingula and Discina." Space will only allow us to mention the new points evolved in this communication. He confirmed Carl Semper's view regarding the circulation of Lingula, viz.: that it was carried on by ciliary motion. The perivisceral cavity was in direct communication with the lacunæ of the mantle, and with the cavity of the peduncle. The circulation was voluminous and rapid; no trace of pulsation could be detected. The fluid was not blood proper, but chyle-aqueous, and distinct from this was the proper heart and blood as pointed out by Hancock.

From repeated examination of the oviducts he could state positively regarding the nature of these organs. The internal mouth was plaited and turned towards the sides, the remaining portion of the oviduct was reddish in color, and glandular, and probably performed a renal function as in similar organs among the annelids.

The sexes were separate. The coiled arms had a limited power of motion. The coils could be raised or depressed, and the axis of the coil could be at right angles to the longitudinal axis of the body or parallel to it.

The contents of the stomach were found in all the lobules of the liver, indicating that the food circulated in these hepatic prolongations, as in the annelids. Upon young Lingula a perfectly circular area could be seen near the beak of the shell; this indicated the form of the embryo shell and coincided with that of Discina. The movements of living *Lingula pyramidata*, upon which these observations were made, were described. As they live in the sand upright, their peduncle encased in a sand tube, it was interesting to notice a modification in their habits when confined in a bowl. In a short time after confinement they had built new tubes which adhered to the bottom of the bowl through their whole length. They would extend from these tubes, or withdraw when alarmed. All of the specimens he had brought from North Carolina in May were alive at this date, August 19th. They had been confined in a small bowl, with a little sand, and the water changed every two or three days. This vitality was suggestive, since Lingula had existed from the earliest geological ages to the present time.

In describing Discina he mentioned in detail, the muscular, alimentary, circulatory and reproductive systems. The oviducts were very conspicuous, and had broad trumpet shaped mouths. The so-called arteries of Hancock were traced to a ganglionic enlargement in the divaricator muscles, and were unquestionably nerves as pointed out by Owen.

Professor EDWARD S. MORSE also made a communication "On Brachiopods as a division of the Annulata." A brief abstract of these views was published in the July number of this magazine. A few new facts have been added which have been noticed under the description of Lingula.

Attention was called to the Sipunculoid worm with its anterior termination of intestine, and oviducts; its long retractor muscles, and the bilobed lophophore of its young, as described by Kowalewsky, as further proofs of the annulate character of the Brachiopods.

Dr. THOMAS HILL read a paper on "The Compass Plant." In June, 1869, Dr. Hill was coming from Omaha to Chicago, on a very dark rainy day, so dark that he could not form any estimate of the points of compass from the sunlight. At three different points on the prairies he noticed young plants of *Silphium laciniatum*, and estimated from them, while going at full speed, the course of the railway track. On reaching Chicago he procured by the kindness of the officers of the C. & N. W. road, detailed maps of the track, and found where he had estimated the bearing at 35°, 75°, and 90°, the true bearings were 31°, 78°, and 90°.

In October, 1869, being detained by an accident at Tama, he gathered seed, and this spring raised a few seedlings. Drought and insects destroyed part of them, and he could only give the history of eight plants, with fourteen leaves. Ten of these fourteen leaves showed a strong disposition, when about four inches high, to turn to the meridian; the other four showed a feeble disposition in the same direction. These ten leaves on coming up in June, had an average bearing of 42°, and the mean bearing was nearly as large. But in August, the same ten leaves showed an average bearing of only 4½°, and the mean bearing was but 2½°.

Dr. Hill refers this polarity to the sunlight, the two sides of the leaf being equally sensitive, and struggling for equal shares. He hoped in a more favorable summer to test this, and several other points which had suggested themselves, by experiments.

Professor JAMES ORTON read a paper upon the "Condor and the Humming Birds of the Equatorial Region." He remarked that probably no bird is so unfortunate in the hands of the curious and scientific as the Condor. Fifty years have elapsed since the first specimen reached Europe, yet to-day the exaggerated stories of its size and strength are repeated in many of our text books, and the very latest ornithological work leaves us in doubt as to its relation to the other vultures. No one credits the assertion of the old geographer, Marco Paulo, that the Condor can lift an elephant from the ground high enough to kill it by the fall; nor the story of the traveller, so late as 1830, who declared that a Condor of moderate size, just killed, was lying before him, a single quill feather of which was twenty paces long. Yet the statement continues to be published that the ordinary expanse of a full grown Condor, is from fifteen to twenty feet, whereas it is very doubtful if it ever exceeds or even equals twelve feet. I have a full grown male from the most celebrated locality in the Andes, and the stretch of its wings is nine feet. Humboldt

never found one to measure over nine feet; and the largest specimen which Darwin saw, was eight and one half feet from tip to tip. An old male in the Zoological Gardens of London, measures eleven feet. It is not yet settled that this greatest of unclean birds is generically distinct from the other great vultures. My own observation of the structure and habits of the Condor, incline me to think it should stand alone. Associated with the great Condor is a smaller vulture, having brown or ash-colored plumage instead of black and white, a beak wholly black instead of black at the base and white at the tip, and no caruncle. It inhabits the high altitudes, and is rather common. This was formerly thought to be a distinct species; but lately ornithologists have with one accord pronounced it the young of the Sarcoramphus gryphus — a conclusion which the speaker did not seem wholly to endorse.

As to the royal Condor, Professor Orton offered the following observations, either new or corroborative: Its usual habitation is between the altitudes of ten thousand and sixteen thousand feet. The largest seem to make their home around the volcano of Cayambi, which stands exactly on the Equator. In the rainy season they frequently descend to the coast, where they may be seen roosting on trees; on the mountains they rarely perch, but stand on the rocks. They are most commonly seen around vertical cliffs, perhaps because their nests are there, and also because cattle are likely to fall there. Flocks are never seen except around a large carcass. It is often seen singly, soaring at a great height in vast circles. Its flight is slow. It never flaps its wings in the air, but its head is always in motion as if in search of food below. Its mouth is kept open and its tail spread. To rise from the ground it must needs run for some distance; then it flaps its wings three times and soars away. A narrow pen is therefore sufficient to imprison it. In walking the wings trail on the ground and the head takes a crouching position. Though a carrion bird it breathes the purest air, spends much of its time soaring three miles above the sea. Humboldt saw one fly over Chimborazo. I have seen them sailing at one thousand feet above the crater of Pichincha. Its gormandizing power has hardly been overstated. I have known a single Condor, not of the largest size, to make way in one week with a calf, a sheep, and a dog. It prefers carrion, but will sometimes attack live sheep, deer, dogs, etc. The eyes and tongue of a carcass are the favorite parts and first devoured; next the intestines. I never heard an authenticated case of its carrying off children, nor of it attacking adults, except in defence of its eggs. In captivity it will eat everything except pork and fried or boiled meat, When full fed it is exceedingly stupid, and can be caught by the hand; but at other times it is a match for the stoutest man. It passes the greater part of the day sleeping, searching for prey in the morning and evening. It is seldom shot (though it is not invulnerable as once thought), but is generally caught in traps. The only noise it makes, is a hiss like that of a goose — the usual tracheal muscle being absent. It lays two white eggs on an inaccessible ledge. It makes no nest proper, but places a few sticks around the eggs. By no

amount of bribery could I tempt an Indian to search for Condor's eggs, and Mr. Smith, who had hunted nearly twelve years in the Quito Valley, was never able to get sight of one. Incubation occupies about seven weeks, ending in April or May (in Patagonia much earlier, or about February). The young are scarcely covered with dirty white brown, and are not able to fly until nearly two years old. D'Orbigny says they take the wing in about a month and a half after being hatched, a manifest error, for they are then as downy as goslings. It is five months moulting, and while at that stage when its wings are useless, it is fed by its companion. As may be inferred the moulting time is not uniform. Though it has neither the smelling powers of the dog (as proved by Darwin), nor the bright eyes of the eagle, somehow it distinguishes a carcass afar off. He described in full the appearance of the Condor, remarking that the female is smaller than the male, an unusual circumstance in this order, the feminine eagles and hawks being larger than their mates.

Professor Orton next spoke of the Humming Bird, of the habits and economy of which our knowledge is very meagre. The relationship between the genera is not clear, and one species is no more typical than another, The only well marked divisions we can discover, are those adopted by Gould and Gray, the Phæthornithinæ and Polytminæ. The former are dull colored and frequent the dense forests. They are more numerous on the Amazon than the other group; and I know of no specimen from the Quito Valley, or from an altitude above ten thousand feet. Their nests are long, covered with lichens, lined with silk and hung over water courses. The latter comprises the vast majority of the Humming Bird, or nearly nine-tenths. They delight in sunshine, and the males generally are remarkable for their brilliant plumage. Their headquarters seem to be near New Granada; some species are confined to particular volcanoes, or an area of a few miles square. Of the four hundred and thirty known species of Humming Birds, thirty-five are found in and around the valley of Quito, thirty-two on the Pacific slope, and seventeen on the Oriental side of the Andes, making a total of eighty-four, or about one-fifth of the family within the Republic of Ecuador. If the wanton destruction of Humming Birds for mere decorative purposes, continues for the next decade, as it has during the last, several genera may become utterly extinct. This is evident when we consider that many a genus is represented by a single species, which species has a very circumscribed habitat, and multiplies slowly, producing but two eggs in a year. He noticed one fact in regard to the nests of Humming Birds, which he could not explain. Our northern hummer glues lichens all over the outside; so do a number of species in Brazil, Guiana, etc. But in the valley of Quito moss invariably is used, though lichens abound. A similar variation is seen in the nests of the chimney swallow — our species building of twigs glued together with saliva, while its Quito representative builds of mud and moss. The time of incubation at Quito is twelve days, and there is but one brood in a year.

Dr. A. S. Packard, Jr., presented a paper on "the Embryology of *Limulus Polyphemus*." The eggs on which the following observations were made were kindly sent me from New Jersey, by Rev. Samuel Lockwood, who has given an account of the mode of spawning, and other habits, in the American Naturalist. They were laid on the 16th of May, but it was not until June 3d that I was able to study them. The eggs measure .07 of an inch in diameter, and are green. In the ovary they are of various hues of pink and green just previous to being laid, the smaller ones being, as usual, white. The yolk is dense, homogeneous, and the yolk granules, or cells, are very small, and only in certain specimens, owing to the thickness and opacity of the egg-shell, could they be detected.

Not only in the eggs already laid, but in unfertilized ones taken from the ovary the yolk had shrunken slightly, leaving a clear space be-

Fig. 95.

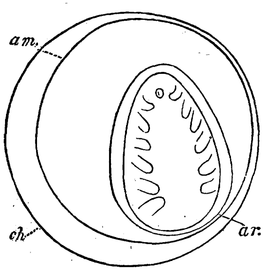
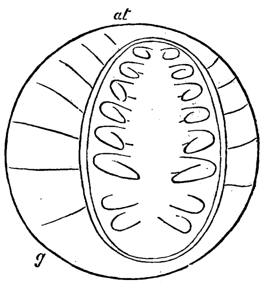


Fig. 96.



Embryo of Limulus.

tween it and the shell. Only one or two eggs were observed in process of segmentation. In one the yolk was subdivided into three masses of unequal size. In another the process of subdivision had become nearly completed.

In the next stage observed, the first indications of the embryo consisted of three minute, flattened, rounded tubercles, the two anterior placed side by side, with the third immediately behind them. The pair of tubercles probably represent the first pair of limbs, and the third, single tubercle the abdomen. Seen in outline the whole embryo is raised above the surface of the yolk, being quite distinct from it, and of a paler hue. In more advanced eggs three pairs of rudimentary limbs were observed, the most anterior pair representing the first pair of limbs (false mandibles of Savigny), being much smaller than the others. The mouth opening is situated just behind them. In a succeeding stage (Fig. 95, *ar*, areola; *am*, blastoderm skin; *ch*, chorion) the embryo forms an oval area, surrounded by a paler colored areola, which is raised into a slight ridge. This areola is destined to be the edge of the body, or line between the ventral and dorsal sides of the animal. There are six pairs of appendages, forming elongated tubercles, increasing in size from the head

backwards; the mouth is situated between the anterior pair. The whole embryo covers but about a third of that portion of the yolk in sight. At this time the inner egg membrane (blastoderm-skin?) was first detected.

The outer membrane, or chorion, is structureless; when ruptured the torn edges show that it is composed of five or six layers of a structureless membrane, varying in thickness. The inner egg membrane is free from the chorion, though it is in contact with it. Seen in profile it consists of minute cells which project out, so that the surface appears to be finely granulated. But on a vertical view it is composed of irregularly hexagonal cells, sometimes 5-sided, and rarely 4-sided, hardly two cells being alike. The walls of the cells appear double, and are either strongly waved, or have from three to five long slender projections, with the ends sometimes knobbed, directed inwards. These cells are either packed closely together, or separated by quite a wide interspace.

In a subsequent stage (Fig. 96) the oval body of the embryo has increased in size. The segments of the cephalothorax are indicated, and

Fig. 97.

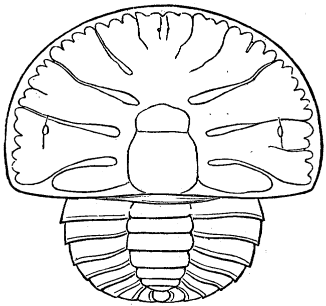
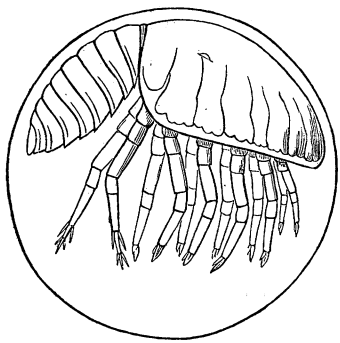


Fig. 98.



Embryo of Limulus just before hatching.

the legs have grown in length, and are doubled on themselves. But the most important change is in the small size of the rudiments of the mandibles, compared with the remaining five pairs of limbs; and the origin of two pairs of gills, forming pale oblique bands between the 6th pair of legs and the end of the abdomen, which forms a narrow semicircular area.

A later stage is signalized by the more highly developed dorsal portion of the embryo, and the increase in size of the abdomen and the appearance of nine distinct abdominal segments. The segments of the cephalothorax are now very clearly defined, as also the division between the cephalothorax and abdomen, the latter being now nearly as broad as the cephalothorax, the sides of which are not spread out as in a later stage. At this stage the egg-shell has burst, and the "amnion" increased in size several times exceeding its original bulk, and has admitted a correspond-

ing amount of sea water, in which the embryo revolves. At a little later period the embryo throws off an embryonal skin, the thin pellicle floating about in the egg.

Still later in the life of the embryo the claws are developed, an additional rudimentary gill appears, and the abdomen grows broader and larger, with the segments more distinct; the heart also appears, being a pale streak along the middle of the back extending from the front edge of the cephalothorax to the base of the abdomen.

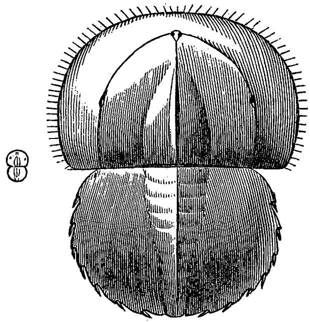
Just before hatching the cephalothorax spreads out, the whole animal becomes broad and flat, the abdomen being a little more than half as wide as the cephalothorax. The two eyes and the pair of ocelli on the front edge of the cephalothorax are distinct; the appendages to the gills appear on the two anterior pairs; the legs have increased in length, though only a rudimentary spine has appeared on the coxal joint, corresponding to the numerous teeth in after life. The trilobitic appearance of the embryo (Fig. 97 top; 98, side view) is most remarkable. It also now closely resembles the Xiphosurian genus *Bellinurus*. The cardiac, or median region is convex and prominent. The lateral regions are more distinctly marked on the abdomen than on the cephalothorax. The six segments of the cephalothorax can, with care, be distinguished, but the nine abdominal segments are most clearly demarked, and in fact the whole embryo bears a very near resemblance to certain genera of Trilobites, as *Trinucleus*, *Asaphus* and others.

In about six weeks from the time the eggs are laid the embryo hatches. It differs chiefly from the previous stage in the abdomen being much larger, scarcely less in size than the cephalothorax; in the obliteration of the segments, except where they are faintly indicated on the cardiac region of the abdomen; and the gills are much larger than before. The abdominal spine is very rudimentary, forming a lobe varying in length, but scarcely projecting beyond the edge of the abdomen. It forms the ninth segment. The young swim briskly up and down the jar, skimming about on their backs, by flapping their gills, not bending their bodies. In a succeeding moult, which occurs between three and four weeks after hatching, the abdomen becomes smaller in proportion to the cephalothorax, and the abdominal spine is prominent, being ensiform and about three times as long as broad. At this and also in the second, or succeeding moult, which occurs about four weeks after the first moult, the young Limulus doubles in size.

Conclusions. The eggs are laid in great numbers loose in the sand, the male fertilizing them after they are dropped. This is an exception to the usual mode of oviposition in Crustacea; *Squilla* and a species of *Gecarcinus* being the only exception known to me to the law that the Crustacea bear their eggs about with them. Besides the structureless, dense, irregularly laminated chorion, there is an inner egg membrane composed of rudely hexagonal cells; this membrane increases in size with the growth of the embryo, the chorion splitting and being thrown off during the

latter part of embryonic life. Unlike the Crustacea generally the primitive band is confined to a minute area, and rests on top of the yolk, as in the spiders and scorpions, and certain Crustacea, *i. e.*, *Eriphia spinifrons*, *Astacus fluviatilis*, *Palæmon adspersus*, and *Crangon maculosus*, in which there is no metamorphosis.

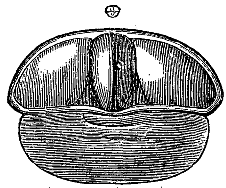
Fig. 99.



Larva of Limulus, natural size, and enlarged.

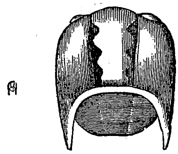
The embryo is a Nauplius; it sheds a Nauplius skin about the middle of embryonic life. This Nauplius skin corresponds in some respects to the "larval skin" of German embryologists.

Fig. 101.



Larva of *Trinucleus ornatus*, natural size, and enlarged.

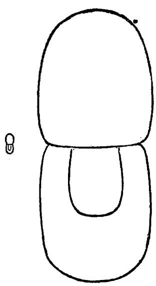
Fig. 102.



Larva of *Sao hirsuta*, natural size, and enlarged.

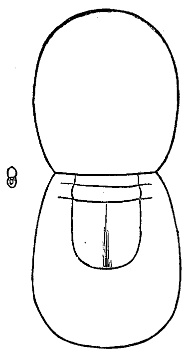
The recently hatched young of Limulus (Fig. 99) can scarcely be considered a Nauplius, like the larvæ of the Phyllopoda, Apus (Fig. 100 *a*) and Branchipus (Fig. 100 *b*), but is to be compared with those of the trilobites, as described and

Fig. 103.



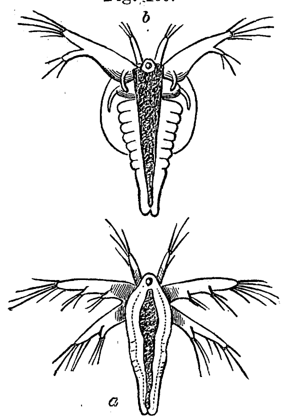
Larva of *Agnostus nudus*, nat. size, and enlarged.

Fig. 104.



Adult *Agnostus nudus*, nat. size, and enlarged.

Fig. 100.



a Larva of *Apus*.
b Larva of *Branchipus*.

figured by Barrande (Fig. 101, larva of *Trinucleus ornatus*; Fig. 102, larva of *Sao hirsuta*; Fig. 103, larva of *Agnostus nudus*) which are in *Trinucleus* and *Agnostus* born with only the cephalothorax and pygidium, the

thoracic segments being added during after life. The circular larva of *Sao hirsuta*, which has no thorax, or at least a very rudimentary thoracic region, and no pygidium, approaches nearer to the Nauplius form of the Phyllopods, though we would contend that it is not a Nauplius.

The larva passes through a slightly marked metamorphosis. It differs from the adult simply in possessing a less number of abdominal feet (gills), and in having only a very rudimentary spine. Previous to hatching it strikingly resembles *Trinucleus* and other trilobites, suggesting that the two groups should, on embryonic and structural grounds, be included in the same order, especially now that Mr. E. Billings* has demonstrated that Asaphus possessed eight pairs of five-jointed legs of uniform size. The trilobate character of the body, as shown in the prominent cardiac and lateral regions of the body, and the well marked abdominal segments of the embryo, the broad sternal groove, and the position and character of the eyes and ocelli, confirm this view. The organization and the habits of Limulus throw much light on the probable anatomy and habits of the trilobites. The correspondence in the cardiac region of the two groups shows that their heart and circulation was similar. The position of the eyes shows that the trilobites probably had long and slender optic nerves, and indicates a general similarity in the nervous system. The genital organs of the trilobites were probably very similar to those of Limulus, as they could not have united sexually, and the eggs were probably laid in the sand or mud, and impregnated by the sperm cells of the male, floating free in the water.

The muscular system of the trilobites, must have been highly organized as in Limulus, as like the latter they probably lived by burrowing in the mud and sand, using the shovel-like expanse of the cephalic shield in digging in the shallow palæozoic waters after worms and stationary soft bodied invertebrates, so that we may be warranted in supposing that the alimentary canal was constructed on the type of that of Limulus, with its large, powerful gizzard and immense liver.

Prof. Gill presented a verbal communication "On the Relations of the Orders of Mammals." He stated that in order to render at once appreciable the course which he had followed in his studies he would enunciate the guiding principles by which he had been influenced. These were five:

1st. Morphology is the only safe guide to the natural classification of organized beings; teleology or physiological adaptation the most unsafe and conducing to the most unnatural approximations.

2d. The affinities of such organisms are only determinable by the sum of their agreements in morphological characteristics, and not by the modifications of any single organ.

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*Proceedings of the Geological Society of London. Reported in "Nature." June 2, 1870. In this communication Mr. E. Billings announces the important discovery of a specimen of *Asaphus platycephalus*, showing that the animal possessed eight pairs of five-jointed feet, widely separated at their insertions by a broad sternal groove.

3d. The animals and plants of the present epoch are the derivatives with modification of antecedent forms to an unlimited extent.

4th. An arrangement of organized beings in any single series is, therefore, impossible, and the system of sequences adopted by genealogists may be applied to the sequence of the groups of natural objects.

5th. In the appreciations of the value of groups, the founder of modern taxonomy (Linnæus) must be followed, subject to such deviations as our increased knowledge of structure necessitates.

The adoption of such principles compels us to reject such systems as are based solely on modifications of the brain, those of the placenta, and those of the organs of progression, such modifications not being coincident with corresponding modifications of other organs, and therefore not the expressions of the sum of agreements in structure.

Commencing with the highest forms of mammals we have, by universal consent, the Primates. This Linnæan order, purged of the Chiroptera referred to it by its founder, includes man, the monkeys, and the lemurs, with their respective allies. It is divisible into two suborders — the Anthropoidea and the Lemuroidea.

The subjects of the next highest group are not so universally recognized, but the Feræ or Carnivora, on account of the nature of the skeleton, the development of the brain, and the organs for the perpetuation of their kind, seem to be most entitled to that rank. This order seems to embrace as suborders the ordinary gressorial Carnivora (Fissipedia) and the Pinnipedia, or Seals, Walrus, etc.

An extinct type — the Zeuglodontes — is related on the one hand to the Seals, and on the other to the toothed Cetaceans. The relation with the latter is, however, the most intimate, and it may be combined with them and the whale-bone whales into one order — the Cete — of which each form represents a suborder. The relations of the order with the Feræ is only masked by the extreme teleological modifications.

Evidently the derivatives from the same stem as the Feræ, the Insectivora, may be placed next in order. The affinity of the Chiroptera to that order is now universally recognized, notwithstanding the extreme teleological modification of its anterior members. The Ungulata are the derivatives from a common stock of a still more generalized type; the development of the brain, organs of generation, etc., indicate their comparatively high rank. Next may be placed the Glires or Rodents, and last of the Placental Mammals, the Edentata, the structure of the skeleton and especially of the skull, the organs of generation, etc., appearing to indicate, with sufficient distinctness, that thus degraded are their rank.

The relations of the subclass Didelphia, with its single order Marsupialia, and of the subclass Ornithodelphia, with another unique order Monotremata are now recognized beyond dispute.

Resuming now the consideration of the sequence by linear series, we may approach by normally specialized forms, the more generalized of each series, and thence in such cases as are necessary diverge in another

direction to the abnormally specialized. We would then have something like the series thus represented on the blackboard (some suborders being omitted), the index hands representing the respective nature and direction of the groups.

Subclass MONODELPHIA.

I.—PRIMATE SERIES.

Order Primates.

Suborder Anthropoidea. Suborder Lemuroidea.

II.—FERAL SERIES.

Order Feræ.

Suborder Fissipedia. ☜ ☞ Suborder Pinnipedia.

Order Cete.

Suborder Zeuglodontes. Suborder Odontocete. Suborder Mysticete.

III.—INSECTIVOROUS SERIES.

Order Insectivora. ☜ ☞ *Order* Chiroptera.

IV.—UNGULATE SERIES.

Order Ungulata.

Suborder Artiodactyla. Suborder Perissodactyla.

Order Hyracoidea. ☜ *Order* Proboscidea. ☞ *Order* Sirenia.

V.—RODENT SERIES.

Order Glires.

Suborder Simplicidentata. Suborder Duplicidentata.

VI.—EDENTATE SERIES.

Order Bruta, *or* Edentata.

Subclass DIDELPHIA.

Order Marsupialia.

Subclass ORNITHODELPHIA.

Order Monotremata.

Any orders than those admitted seem problematical, and the adoption of an order Bimana for man alone — much more a subclass — seems to be opposed by every sound principle of Taxonomy. There is scarcely a proposition in biology more demonstrable than that man is the derivative from the same immediate stock as the higher anthropoid apes, and probably after the culmination to nearly the same extent as at present of the differentiation of the order into families and subordinate groups.

Professor A. Winchell read "Notes on some Post Tertiary Phenomena in Michigan." This paper was intended simply to make note of three classes of phenomena recently observed in Michigan.

The first note was in reference to the relics found in and beneath the numerous peat beds of the state. These beds are the sites of ancient lakelets that have been slowly filled by the accumulation of sediments. They inclose numerous remains of the mastodon and mammoth. These are sometimes found so near the surface that one could believe they had been buried within five hundred or a thousand years. For the first time, too, the remains of the gigantic extinct beaver of North America (*Castoroides Ohioensis*), have been recently found in Michigan. What is perhaps most interesting of all, is the discovery of a flint arrowhead in a

similar situation. This arrowhead was found seven feet beneath the surface in a ditch excavated in the southern part of Washtenaw county. The mastodon remains found near Tecumseh, but a few miles distant, lay but two and a half feet beneath the surface. The Adrian mastodon was buried but three feet deep.

The second note related to the occurrence of enormous beds of bog iron in the upper peninsula of Michigan, on the tributaries of the Monistique river. It occurs in a half desiccated bog covering several townships. It is of remarkable purity, and of great but unknown depth. It lies directly in the track of the projected railroad, intended to connect the North Pacific Railroad with the railroad system of Michigan. The ore can be floated down the Monistique and its tributaries, to Lake Michigan, in the immediate vicinity of an excellent harbor. This immense deposit is undoubtedly derived from the desintegration of the hæmatites and magnetites of the contiguous region on the West. The ore will possess great value for mixing with the other Lake Superior ores.

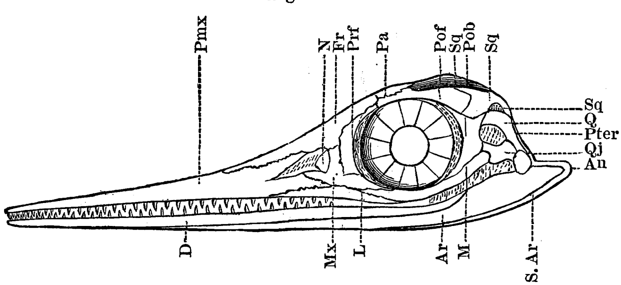
The third note was on the discovery of an ancient outlet of Lake Superior. Following the White Fish river from the head of Little Bay de Noc, we find it occupying a broad and deep valley walled in on both sides by limestone cliffs attaining an elevation of one hundred and twenty feet. The head waters of this river literally interlace with those of the Au Train river, which runs north into Lake Superior. Here is a vast valley of erosion but little elevated in any part above the present level of Lake Superior. Through this the waters of that lake must have flowed in a powerful stream in that earlier epoch when all the lakes stood from fifty to three hundred feet higher than at present. There are many evidences of glacier action along this valley. The striæ at Marquette, near the head of the valley, point North and South. In short, the evidences lead to the conviction that a vast glacier stream once traversed this valley and was probably the agency by which it was excavated. Little Bay de Noc is but the prolongation of this valley at a lower level; and, indeed, the whole basin of Green Bay seems to be but a phenomenon of erosion belonging to the epoch of the same glacier system.

Prof. E. D. Cope read a paper "On the structural Characteristics of the Cranium in the lower Vertebrata (Reptiles, Batrachia and Fishes)," giving a new systematic arrangement of the Reptilia, and determining for the first time the structures of the posterior regions of the crania in Dicynodons and Ichthyosauri.

He first pointed out the homologies of the squamosal bone, stating that it was to be recognized as the posterior half of the zygomatic arch. The zygomatic and quadratojugal are the two cranial arches which have occasionally been mistaken the one for the other, for example in the Ichthyosaurus and Sphenodon, by their describers. The squamosal was shown to be present in all reptiles except the serpents, and to be homologous, or identical, with the "temporo-mastoid" of the frog, and the preoperculum of osseous fishes, by comparison with Lepidosiren. This was proven by

the development of this element in the Dicynodons and Ichthyosaurus, where it had heretofore been erroneously determined. Thus in Ichthyosaurus it was the "supratemporal" of Owen, and besides forming the posterior half of the zygomatic arch it descended posteriorly to about opposite the middle of the posterior face of the os-quadratum. Further, it had an extensive development on the inner face of the temporal fossa reaching round nearly or quite to the postfrontal, and sending down a columella to the pterygoid. This supero-anterior portion was the parietal of Owen. The true parietal was in advance of this, and embraced the usual fontanelle, while the frontals were the nasals of Owen. The

Fig. 105.*



true nasals he recognized in small bones, one at the posterior extremity of each exterior nostril.

Turning to the Dicynodont genus Lystrosaurus, he stated that the form of the squamosal bone was very similar to that seen in Ichthyosaurus, but that it extended postero-inferiorly much further. It concealed the quadratum when viewed from behind; the latter was small and occupied a position at the inferior extremity on the intero-anterior side of the squamosal, and was attached to the pterygoid inwardly. He thought that this structure bore an analogy to that seen in the Batrachia, where the quadratum is similarly concealed. He thought the bone in the Anura, Urodela, and Dipnoi, which Huxley had suggested was the preoperculum of the Teleosts, was truly the squamosal of the higher vertebrata.

He further pointed out that Lystrosaurus possesses a columella having a superior origin quite similar to that of Ichthyosaurus. The distinctness of the proötic was pointed out as Chelonian and Lacertilian, and the presence of the parietal arches as distinct from the opisthotics was insisted on, they having been united by Owen. He then gave new deter-

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* Fig. 105.—Ichthyosaurus; lateral view (from specimen from Barrow, Leicestershire).

Pmx. . Premaxillary bone.
Mx. . . Maxillary.
N. . . . Nasal.
Fr. . . . Frontal.
Prf. . . Prefrontal.
Pof. . . Postfrontal.
Pa. . . . Parietal.
L. . . . . Lachrymal.
M. . . . Malar.
Qj. . . . Quadratojugal.
Q. . . . . Quadrate.
Pob. . . Postorbital.
Sq. . . . Squamosal.
D. . . . Dentary.
An. . . . Angular.
Ar. . . . Articular.
S. Ar. . Subarticular.
Pter. . Pterygoid.

minations of the opisthotic bone in the various orders of reptiles, rectifying errors which existed in modern works on comparative anatomy. He considered the suspensorium of the Ophidia to be the opisthotic and not the squamosal as given by Huxley, explaining it by reference to figures of those regions in Clidastes and Cylindrophis. In the first genus the element in question bears the squamosal on its extremity as in the Testudinata, and in the latter it forms part of the cranial walls, being supported by the exoccipital and proötic, as in Clidastes. The remarkable enlargement of the ear bones in the same groups was then described, and the homologies with the metapterygoid and symplectic of fishes and quadrate of reptiles, and of the anvil with the hyomandibular of fishes, as pointed out recently by Huxley. He pointed out a bone in Ichthyosaurus which he thought might be the hyomandibular. It is postero-interior to the quadrate, and below the opisthotic. He had not found it

Fig. 106.*

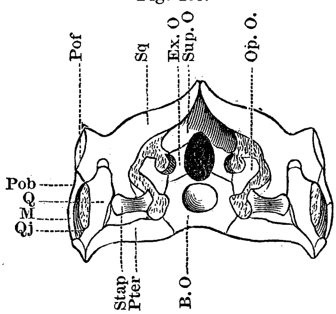
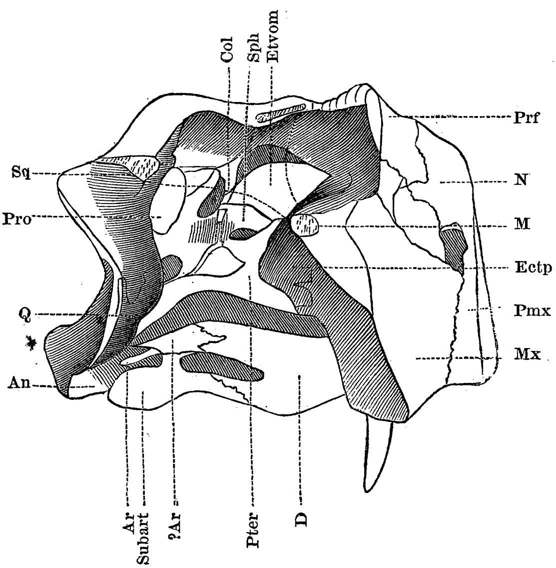


Fig. 107.†



* Fig. 106.—Ichthyosaurus; cranium; posterior view. Lettering the same as in 105 with the following additions:—

B. O. . . Basioccipital.
Ex. O. . Exoccipital.
Sup. O. Supraoccipital.
Op. O. . Opisthotic.
Stap. . . Suprastapedial or hyomandibular.

† Fig. 107.—Lystrosaurus frontosus (from Cape Colony); profile. Lettering as in 105 and 106 with the following additions:—

Etvom. . Ethmovomerine.
Sph. . . . Sphenoid.
Pro. . . . Prootic.
Pter. . . Pterygoid.
Col. . . . . Columella.
Ectp. . . . Ectopterygoid.
Subart. . Subarticular.

described. He thought that the element in Ichthyosaurus, called by authors the squamosal, was really the quadratojugal.

He next pointed out the various origins of the columella, a bone peculiar to reptiles, and designed to support the roof of the cranium. In Ichthyosaurus and Dicynodon it originated from the squamosals, in tortoises from the parietal, in crocodiles from the alisphenoid, and in lacertilia the origin could not be discovered.

He spoke of the proposition of Huxley, that some of the earlier types of reptilia in geologic time were not more generalized than those now existing. He took exception to this, and stated that the Dicynodon, among the earliest of the groups (Triassic) was the most generalized. Thus he showed it had five characters of Ichthyopterygia, three of Testudinata, two of Rhynchocephalia, three of Dinosauria, one of Lacertilia, and one of Crocodila.

The system of Reptilia proposed was the following:

(A). Attached quadrate.	
I. Parts of extremities not differentiated; ribs two headed to centrum.	*Ichthyopterygia.*
II. Extremital parts differentiated:	
1. Head of rib sessile on centrum tubercle to spine.	*Testudinata.*
2. Capitular surface on centrum, tubercular on neural arch.	*Archosauria.*
3. Capitular and tubercular united, rising to neural arch.	*Synaptosauria.*
(B). Quadrate, free, mobile.	
1. Ribs double headed; a quadratojugal. . .	*Ornithosauria.*
2. Ribs single headed; no quadratojugal.	
(a). No alisphenoid; a columella; opisthotic, all attached; feet.	*Lacertilia.*
(b). Alisphenoid, no columella; opisthotic fixed, styloid; paddles.	*Pythonomorpha.*
(c). Alisphenoid; no columella; opisthotic, free, mobile.	*Ophidia.*

Mr. J. B. Perry read a paper on "The Supposed Elevation and Depression of the Continent during the Glacial Period." Many geologists have supposed an elevation of the northern part of the continent necessary in order to the existence of the Ice Period, and of the phenomena peculiar to it. Without resorting to a supposition of this kind wholly unauthorized by positive evidence, we may invoke certain astronomical facts which, in their combination, were perhaps sufficient to produce this great winter of the ages. Intense cold being thus occasioned by cosmical influences, the formation of an ice sheet of vast extent would naturally follow, especially if there were abundant moisture. The fact of intense igneous activity, near the close of the Tertiary Period, suggests the occurrence of immense evaporation, and thus a source of aqueous supply. An ice-

sheet might thus be formed. Great cold prevailing on its northern limits and serving as a barrier to its motion in that direction, there being at the same time a partial melting of its southern face, the waters from the wasting snows on its surface percolating the icy mass, there also being contractions and expansions consequent upon alternations in the temperature; all these being connected with the gravitating force of a mass from five thousand to ten thousand feet in thickness, motion to the south would inevitably result, even on a horizontal surface, and much more if there were a southward inclination of the country. Under these circumstances we have an instrumentality fully able to plane, smooth, and striate the rocky floor of the continent as it now appears, and thus to account for the debris almost everywhere met with in great abundance.

But if there were no elevation of the country, how are we to explain the occurrence of pot-holes in places apparently never traversed by torrents; the formation of fiords; the existence of sub-marine river-channels, as those extending from the mouths of the Hudson and the Connecticut; or the fact of sub-aërial deposits, as mud-flats, now found beneath the level of the ocean? It is well known that, when glaciers meet with obstructions, breaks (known as *moulins*) occur in them; that the snows melting on the surface of the ice-mass, streams are formed, which flow into these breaks, and thus become torrents and cascades, which wear pot-holes in every respect similar to those requiring explanation. Again it should be remembered that such an ice-sheet moving seaward must, in displacing the waters along the shallow margin of the ocean, do its legitimate work of erosion, and that thus old depressions would be deepened, while new valleys and fiords would be formed, as well as sub-marine river-channels, which remain to this day. Accordingly all this erosion might readily take place without an elevation, even if the sea were at its present height. But this leads us to ask, whence came the immense ice-sheet; undoubtedly for the most part from the ocean. Thus its waters must have undergone a great depression, perhaps one of several hundred feet; and this enables us to account for the mud-flats and other like deposits, which were probably laid down when the ocean was at a lower level than it is to-day.

It has been, moreover, thought necessary to suppose that a depression of the continent finally followed its conjectured elevation. The land having been lifted up, it must be got down again, in order that there might be a return of warmth, and things be as we now find them. Now marine organic remains seem to attest a depression, in some places, of about five hundred feet. But so slight a submergence of the land, there being upon it an ice-sheet thousands of feet in thickness, could not cause a return of warmth, while the cosmical agencies already referred to are abundantly sufficient for the production of such an effect. This summer of the ages thus coming on, the ice-sheet as gradually melting must retreat northward. And the waning of the glacial mass would be accompanied by results which require an explanation.

The ice thawing, the detrital matter which lay beneath it, and is now known as typical drift, would be laid bare and left substantially as we find it. In this view a resort to a depression of five thousand or six thousand feet, and to iceberg agency, is unnecessary. Indeed, Arctic icebergs could not furnish the material of New England typical drift, since it is for the most part of local origin; while bergs of ice from the White Mountains could not have supplied it, for it is a continuous sheet, having a uniform glaciated character, spreading over vast areas lying far to the north of these mountains. So icebergs could not have deposited it, because, as they slowly wasted, the particles of matter must have been scattered by the flux and reflux of the tides, and thus to a large extent stratified. Again, from the southern border of the wasting ice-sheet, floods of water would flow, working over and remodeling portions of the detrital masses, bearing some of the finer material southward, and laying down those deposits known as modified drift. These constitute in part the terrace formations, which usually slope with the rivers along which they occur. In some instances there were barriers obstructing the waters; thus were formed ponds and lakes, in which deposition took place in more nearly horizontal layers. Finally from the wasting of the ice-sheet the surface of the ocean must be elevated, its waters spread over the lower levels of the still slightly depressed lands, laying down beds containing marine organic remains, which to-day bear witness of a partial depression. In due time, after the disappearance of the ice-sheet, the continent would resume its normal elevation, the brackish waters of the ocean be excluded, and all things come gradually to take the position in which we now find them.

In conclusion it may be asked whether the explanation suggested be not in consistency with the facts, and thus whether we ought not to accept it, rather than arbitrarily to resort to the assumption of a vast continental elevation and depression, which if not disproved, is at least unsupported by positive evidence.

Mr. Dall described three new generic forms of Brachiopoda, principally from the collections of the United States Exploring Expedition. Two of these belonged to the group of articulated Brachiopods, while the third was that animal, which, under the name of Lingula, had just been described by Mr. Morse. Mr. Dall then spoke of several special points of structure, especially the peduncle of Lingula, demonstrating its construction to be analogous to that of the siphons of bivalve mollusks, such as the common clam, *Mya arenaria*. He then described the bristles of Lingula, showing that they were quite different in construction from those of the worms, and also that the Chitons were (in some genera) provided with true follicular setæ, proceeding from the mantle. Hence these characters cannot be held to afford satisfactory evidences of affinities with Annelids. Mr. Dall then proceeded to discuss the theory of Mr. Morse, that the Brachiopods were a subdivision of the Annelids. Mr. Dall took the opposite view, and, while admitting all the facts

brought forward by Mr. Morse, and fully appreciating the careful and thorough nature of his researches, contended on the other hand that these facts were susceptible of quite another interpretation.

Mr. Dall then went on to take up, one by one, the circulatory, nervous, muscular, and digestive systems of the Brachiopods, and to compare each with the same organs in the Annelids and the Mollusks, and came to the conclusion that the weight of structural characters was essentially of a Molluscan nature. The Mollusks were an individualized type, while the Annelids, and even most of the Articulates were typified by their repetition of similar organs. No such repetition obtains among the Brachiopods. Mr. Dall was of the opinion that the Molluscoidea should rank as one of two great primary divisions of the Mollusca — one, the true Mollusks, typified by the Gasteropoda, and second the Molluscoidea, typified by the Brachiopoda. The second division would include the Polyzoa, Tunicata, and Brachiopoda, and Mr. Dall was of the opinion that these groups were essentially related to one another, and cannot be separated without violence to their affinities.

In reply to Mr. Dall's communication and objections advanced, Prof. Morse replied in brief as the time for adjournment had passed. He would only take a few moments in correcting some points in which Mr. Dall had evidently misunderstood the general articulate characters claimed for the Brachiopods. In this respect his demonstration of the striated muscular fibre in the Brachiopods accorded well with the views advanced, inasmuch as striated muscular fibre is a great characteristic of the crustacea, and does not occur in the mollusks. Mr. Dall did not know of any tubicolous worms having a blind intestine. Professor Morse referred him to certain worms in the inferior groups. His views on Chiton were rather strange, seeing that Chiton presented articulated characters in its development, the presence of a dorsal vessel, the terminal opening of intestine, and the forward opening of oviducts. As to a comparison between the peduncle of Lingula and the syphonal tubes of Mya, the relations were so different that they could not enter the discussion whatever. The related points, as indicated by the structure of the oviducts, were not properly appreciated by Mr. Dall. He referred to the figure still kept upon the board as presenting all the points involved, and would demand a molluscan character in the Brachiopods. He then carried out the points raised by Mr. Dall, by citing other mollusks, with strong articulated features, which Mr. Dall had overlooked.

Mr. Thomas Meehan read a paper "On the Laws of Fasciation, and its relation to Sex in Plants." He said that in trees, branches often came out in thick masses, which botanists called "fasciations," and the people "Crow's Nests." An over supply of nutrition was the received theory of their origin. He believed the reverse to be the fact. In proof of this he stated that the shoots forming the bunch of branches never grew as vigorously as the others, the leaves were of a paler hue, and in evergreens, the leaves were deciduous. Many of the shoots died in severe winters.

All these results were due to imperfect nutrition, the effect of which was a low state of vitality. That weakness produced the fascicle was also proved on the theory propounded in his Chicago paper, "Adnation in Coniferæ." There it was seen that distichous leaves in coniferæ came only with increased vigor of growth. The leaves were less free from cohesion with the stem in proportion as vitality was low. Here were the same facts. The leaves on the fascicle of the Balsam Fir were of the same nature as the weak leaves described in the paper referred to. Mr. Meehan had also shown, at the Salem meeting, that sex was influenced by the condition of vitality. The male sex followed from a loss of vigor. Here the same law followed fasciation. The fasciated bunches in the Blackberry, produced foliaceous calyx sepals; and where the bunches were of numerous branchlets, an increase of petals followed. In a variety known as Willson's Early, the number of branchlets in the bunch was often greater than in other instances. Then the female organs were nearly all aborted, and the flowers were completely *double*. Thus proving at once that weakness was unfavorable to the female sex, and proportionately favorable to fasciation. The conclusion reached, was that fasciated branches, or "Crow's Nests," are the consequence of impaired nutrition or vitality.

Mr. Thomas Meehan read a paper "On objections to Darwin's Theory of Fertilization through Insect Agency." He said that the discoveries of Darwin had disclosed wonderful apparent arrangements for fertilization through insect agency; but occasionally instances were found where with the most perfect facilities insects seemed to make no use of them. These had been considered as objections to a full acceptance of Mr. Darwin's theories. The Salvia was an instance. The lower division of the anther acted as a petaloid lever, closing the throat of the corolla tube, which *ought* to throw the pollen on the back of the bee when it entered for the honey. The principle was perfect. *But no insect is seen to enter.* On the other hand the Humble Bee, "without which," Darwin says, "some species would die out in England," bores a hole on the outside, through which it gets the honey. The Humble Bee thus seems to avoid its duty here. A similar state of things exists in the Petunia of our gardens. The humble bee extracts the honey by making a slit in the tube, and avoids interference with the pollen. But Mr. Meehan found that these flowers are the favorite resort of Sphinx's and other night moths, which do extract the honey from the mouth of the tube, and thus cross fertilize. It would thus seem that plants not only do as a rule prefer fertilization by insect agency, but probably some classes of flowers have their preferences for certain classes of insects. In the case of Salvia, probably some insects peculiar to their native countries, fertilize them; especially is this probable, as in cultivation the Salvia produces very little seed.